SUMMARIES OF CURRENT NORTH AMERICAN PRE-CAMBRIAN LITERATURE.[1]

Van Hise,[2] Bayley, and Smyth map and describe[3] the geology of the Marquette iron-bearing district of Michigan. The pre-Cambrian rocks of the district comprise three series, separated by unconformities. These are the Basement Complex or Archean, the Lower Marquette, and the Upper Marquette, the two latter constituting the Algonkian for this district. All of these are cut by basic intrusives. The pre-Cambrian rocks are unconformably overlain by Cambrian sandstone.

The Basement Complex occurs in two main areas, one north of the Marquette series, called the Northern Complex, and one south of the Marquette series, called the Southern Complex. There are also isolated areas within the Algonkian. The oldest rocks of the Basement Complex are thoroughly crystalline, foliated schists and gneisses. A close field and laboratory study has failed to detect in them any evidence of sedimentary origin. These gneisses and schists have been cut by various igneous rocks at different epochs. The latter occur both in the form of great bosses and in dikes, sometimes cutting, sometimes parallel to, the foliation of the rocks. In the area of the Northern Complex there have been volcanic outbursts, and a vast series of lavas, agglomerates, greenstone-conglomerates, and tuffs have been piled up. By far the greater part of the volcanic material is of an intermediate or basic character.

The Northern Complex is treated under the divisions of Mona schists, Kitchi schists, gneissoid granites, hornblende-syenites, basic dikes, acid dikes, peridotite, and ferruginous veins. The Mona and Kitchi schists are greenstone-schists, which are believed to be largely

[1] Continued from page 541, Vol. VI., this JOURNAL.

[2] The Marquette iron-bearing district of Michigan, by C. R. VAN HISE and W. S. BAYLEY; with a chapter on the Republic Trough by H. L. SMYTH: Mon. U. S. Geol. Surv. No. 28, 1896, pp. 1 – 607. With atlas of 39 plates. Preliminary report on same district, published in the 15th Ann. Report U. S. G. S., 1895, pp. 477–650.

[3] The Algonkian rocks are described by VAN HISE; the Basement Complex and later igneous rocks are described by BAYLEY; the Republic Trough is described by SMYTH.

recrystallized volcanic materials. Their original forms included both tuffs and lavas. The gneissoid granites and syenites are plutonic intrusive rocks within the greenstone-schists. The basic dikes are mainly diabase. The peridotite is older than the Cambrian sandstone and younger than the greenstone-schists of the Basement Complex. The ferruginous veins are believed to be water deposited, and were formed previous to the deposition of the Lower Marquette series.

The Southern Complex differs from the Northern Complex in the smaller quantity of greenstone-schists in the former and in the presence in it of the micaceous and hornblendic schists, and the Palmer gneiss. It is treated under the divisions micaceous schists, amphibole-schists, gneissoid granites, Palmer gneiss, and intrusives. The micaceous schists include muscovite-schists, biotite-schists, feldspathic biotite-schists, and hornblendic biotite-schists. They are thought to be mashed acid eruptives. The amphibole-schists include greenstone-schists, hornblende-schists, and micaceous hornblende-schists. They are shown to be mashed basic eruptives. The granites and dike materials are similar in their essential features to the corresponding rocks of the Northern Complex. The granites are younger than the schists, since dikes from them intrude the schists. The Palmer gneisses occur only on the borders of the granite areas, between these and the Marquette sedimentaries, and are apparently in most cases extremely mashed phases of the granites.

The isolated areas of the Fundamental Complex within the Algonkian are chiefly gneissoid granites and schistose greenstones, that differ in no essential respect from the corresponding rocks of the Northern Complex and Southern Complex.

The Lower Marquette series is composed of the following formations, given from the base upward: The Mesnard quartzite, the Kona dolomite, the Wewe slate, the Ajibik quartzite, the Siamo slate, and the Negaunee iron formation. There is no break between these formations; the series is a continuous one.

The Mesnard quartzite is chiefly a metamorphosed sandstone. However, at the bottom of this formation is a conglomerate, which in grading into the sandstone passes through slate and graywacke. The conglomerate is basal, being composed of detritus from the Basement Complex. At the top of the formation is a slate. The Mesnard quartzite is the first deposit of the westward transgressing Lower Marquette sea. By the time the sea had advanced westward a short

distance upon the Marquette district, the Kona dolomite began to be formed, and hence the Mesnard formation is confined to the eastern part of the district. The thickness of the Mesnard quartzite is from 150 to 670 feet.

The Kona dolomite is largely an altered limestone, but it includes interstratified layers of slate, graywacke, and quartzite, with gradation phases between these and the pure dolomite. The Kona dolomite, like the Mesnard quartzite, is confined to the eastern part of the district. The dolomite varies through a slate into the Mesnard quartzite below, and by a lessening of the calcareous constituent gradually passes into the Wewe slate above. The thickness is from 425 to 1375 feet.

The Wewe slate is chiefly a metamorphosed mudstone, but with the slates are conglomerates, quartzites, graywackes, mica-slates, and mica-schists. The Wewe slate, like the two previous formations, is confined to the eastern part of the district. The formation grades into the Kona dolomite below and the Ajibik quartzite above. The thickness is from 550 to 1050 feet.

The Ajibik quartzite, is mainly a metamorphosed sandstone, which in different parts of the district, depending upon various conditions, has been transformed into quartzite, cherty quartzite, ferruginous quartzite, ferruginous cherty quartzite, quartz-rock, and quartzite-breccia. The time of the Ajibik quartzite marks a rapid advance to the west of the Lower Marquette sea, and therefore the formation extends to the western end of the district. In the eastern part of the area the Ajibik quartzite grades down into the Wewe slate, but for the major part of the district it rests unconformably upon the Basement Complex. At many localities contacts and basal conglomerates are known. The Ajibik quartzite grades above either into the Siamo slate or into the Negaunee iron formation. The thickness is from 700 to 900 feet.

The Siamo slate is chiefly an altered mudstone, although locally it is a graywacke or quartzite. The larger area of exposure of the formation is confined to the eastern part of the district, although a belt of the formation runs near the north side of the Marquette series to the west end of the district. The Siamo slate grades into the Ajibik quartzite below and into the Negaunee iron formation above. The thickness is from 600 to 1200 feet.

The Negaunee iron formation is nonfragmental, heavily ferruginous

throughout, and contains the greater iron ore deposits of the district. The formation comprises sideritic slate, which may be grüneritic, magnetitic, hematitic, or limonitic; grünerite-magnetite-schist; ferruginous slate; ferruginous chert; jaspilite, and iron ore. Large quantities of intrusive greenstones are associated with the formation, the masses of which vary in magnitude from great bosses two miles or more long and a half mile wide to small dikes. The largest area of the Negaunee formation is in the east-central part of the district. From this area two belts extend west to the western end of the district. Upon the whole the formation is soft, and occupies lowlands between the more resistant greenstones and the Ajibik quartzites. The formation is underlain by the Siamo slate or Ajibik quartzite, into which it grades, and is overlain unconformably by the Upper Marquette series.

The sideritic slate is the original form from which the other varieties of rock have developed. The grünerite-magnetite-schists were formed by partial recrystallization of the silica, by oxidation of the iron oxide in part to magnetite, by a union of a part of the silica and iron protoxide, producing grünerite, and with the loss of carbon dioxide. The ferruginous slates are the direct result of the decomposition of the iron carbonate and the peroxidation of the iron, with partial or complete recrystallization of the silica. The ferruginous cherts differ from the ferruginous slates in that the iron oxide and the chert are largely concentrated into alternate bands. The jaspilites differ from the ferruginous cherts in that each of the quartz grains of the chert bands is stained red by included hematite. The iron ores resulted from the concentration of the iron oxides through the agency of downward-percolating waters. These concentration-bodies usually occur upon impervious basements in pitching troughs. The pitching troughs are formed by the Siamo slate, the Ajibik quartzite, a mass or dike of greenstone, or by some combination of these. The ore deposits are likely to be of large size where, as a result of the folding, the iron-bearing formation is much fractured, thus permitting the ready access of percolating waters. The ore deposits occur at the bottom of the Negaunee formation, within the Negaunee formation, and at the contact horizon between the Negaunee formation and the overlying Ishpeming formation. From the position of the ore deposits above the impervious formations, it is concluded that their concentration occurred during or subsequent to the folding which took place later than Upper Marquette time.

The Upper Marquette series is composed of the following formations, from the base upward: The Ishpeming formation, the Michigamme formation, and the Clarksburg formation, in conformable succession.

The Ishpeming formation includes two classes of rocks, which are called the Goodrich quartzite and the Bijiki schist. These rocks are sufficiently different to have different formation names, but the Bijiki schist for the west end of the district occupies a part of the horizon of the Goodrich quartzite in the central part.

The Goodrich quartzite includes quartzites, micaceous quartz-schists, mica-schists, mica-gneisses, and at the base a basal conglomerate. For the major part of the district this conglomerate rests upon the Negaunee formation, and the rock is an ore, chert, jasper, and quartz conglomerate. At a few places the Archean rocks are subjacent, and here their materials predominate in the conglomerate. The Goodrich quartzite is confined to the central and western parts of the district. For the major part of the district it rests unconformably upon the Negaunee formation. In places erosion has cut through the Negaunee formation into the Ajibik quartzite, and in a few cases even to the Archean, and here the Goodrich quartzite may be found resting on the lower formations. For the greater part of the area the Goodrich quartzite grades up into the Michigamme or Clarksburg formation, but in the northwestern part of the district it passes up into the Bijiki schist. The thickness is from 600 to 1550 feet.

The Bijiki schist is a banded grünerite-magnetite-schist, which has been derived by metasomatic and dynamic processes from an impure siderite. It is confined to the western part of the district. The Bijiki schist grades into the Goodrich quartzite below and into the Michigamme formation above. The thickness is from zero to 520 feet.

The Michigamme formation includes slates, graywackes, mica-schists, and mica-gneisses. The formation is exposed in a single large belt, running from the center to the western end of the district. It grades below into the Goodrich quartzite, Bijiki-schist, or Clarksburg formation. The thickness cannot be accurately estimated, but it is probably as much as 2000 feet.

The Clarksburg formation is composed predominantly of volcanic materials, embracing basic lava flows, tuffs, ashes, and breccias, which locally are interleaved with or grade into slate, graywacke, or conglom-

erate. Much of the material has been profoundly metamorphosed, and schist-conglomerates, mica-schists, and hornblende-schists have resulted. All of these rocks are cut by dikes and masses of greenstone. The formation is confined to the south central part of the district. The volcanic material was poured out from the number of vents, the more important ones which have been recognized being located near Clarksburg, Greenwood, and Champion. The formation grades into the Ishpeming formation or the Michigamme formation below, and into the Michigamme formation above. The Clarksburg formation belongs in age, either between the Goodrich quartzite and the Michigamme formation, or near the base of the latter. No estimate of the thickness can be given.

The igneous rocks, other than those of the Clarksburg formation, are divided for convenience in discussion into two classes, in the first of which are placed those associated exclusively with the beds below the Clarksburg formation, and, in the other, those cutting also the beds above the Clarksburg. The rocks are all basic. The older rocks occur as dikes, bosses, sheets, and tuff beds, although the latter two are subordinate. The post-Clarksburg greenstones comprise only dikes and bosses. It is conjectured that these later greenstones may be the equivalents of some of the Keweenawan eruptives.

Evidence of the unconformity between the Lower Marquette series and the Basement Complex is clear and abundant. At numerous places in the district the actual contacts of the basal conglomerate of the Marquette series and the Fundamental Complex may be seen. In all of these cases the detritus is most distinctly waterworn, and, while the major part of the material in each case has been derived from the immediately subjacent part of the Basement Complex, other material not occurring in the immediate neighborhood is found, thus showing conclusively that these rocks are not reibungs or fault breccias. There may be mentioned the principal localities at which contacts are well exposed.

At the east end of the south side of the Marquette district there are several localities, from Lake Superior to west of Lake Mary, where a conglomerate is found bearing numerous bowlders of granite, gneiss and schist, identical with the rocks constituting the Basement Complex immediately adjacent. In Secs. 22 and 23, T 47 N, R 26 W, are two islands of the Basement Complex, about which are found magnificent exposures of great bowlder-conglomerate and recomposed granite,

resting with visible contact upon the Basement Complex, and composed of material mainly derived from it. South of the Cascade range, there are again a number of localities from Secs. 34 to 32, T 47 N, R 26 W, where there are basal conglomerates, the great bowlders again being mainly identical with the adjacent granites, gneisses, and schists of the Basement Complex. South of Summit Mountain, in the west half of Sec. 25, T 47 N, R 27 W, is an exposure of the basal conglomerate. The conglomerate grades downward into a schist which is scarcely distinguishable from the Palmer gneiss, with which it is in contact. The next contact to the west is in Sec. 28, T 47 N, R 27 W, where the phenomena are similar to those south of Summit Mountain. At the end of the Republic Trough a conglomerate hangs with visible contact upon the flank of the Archean granite, bearing well rounded waterworn bowlders from it.

At the north side of the Lower Marquette series, and near the east end of the district there is exposed a magnificent basal conglomerate about three miles west of Marquette, north of Mud Lake. The next contacts to the west are at the base of the quartzite east and west of Teal Lake. At one place here the relations are such that the layers of the conglomerate cut across the foliation of the subjacent schists at an acute angle. Still farther west, in Sec. 30, T 48 N, R 28 W, contacts are found in a number of places. West of this point the only actual contact known is north of the Michigamme mine.

The unconformity between the Lower Marquette and Upper Marquette series is also well marked. At the close of Lower Marquette time the land was raised above the sea, gently folded and eroded, and the Upper Marquette sediments were later laid down unconformably upon this floor. In general the discordance between the Lower Marquette series and the succeeding series is not great, being measured frequently by five to ten degrees, at other times by ten to fifteen degrees, and it is only rarely that the plications of the lower series are such as to make the beds abut perpendicularly against those of the overlying series. Erosion has cut deeper in the Lower Marquette series in some places than in others, so that the Upper Marquette series rests upon different members of the lower series. At the east end of the area it left a very considerable thickness of the iron-bearing formation, but in places to the west this formation is quite cut out. Indeed, in places erosion cut through the Siamo slate and the Ajibik quartzite, and in some places even into the Basement Complex. This

particularly occurs in the west and southwest parts of the district, west of Champion and along the Republic Trough, where but few members of the Lower Marquette series were deposited. Even within a short distance the differential erosion was considerable. For instance, at the south end of the Republic Trough the variation was more than 1500 feet.

The Marquette district has been folded in a complex manner. The largest but least conspicuous fold of the district is an anticline having a north-south axis, running through the city of Marquette. This great fold has, especially near its crown—that is, for the eastern six or eight miles of the district—folds of the second order superimposed upon it, making this part of the fold an anticlinorium. The other major anticline belonging to this system of folds is one running north and south through the east end of Michigamme Lake. The major part of the district has been affected, however, by much more effective pressure in a north-south direction, so that the folds in an east-west direction are much more conspicuous than the north-south folds of greater wavelength and greater amplitude. As a result of the north-south pressure, the Upper and Lower Marquette series together have been bent into a great abnormal synclinorium. This synclinorium is of a peculiar and complicated character. The Algonkian rocks on either side of the trough have moved over the more rigid Archean granite, and, as a consequence, on each side of the Algonkian trough a series of overfolds plunge steeply toward its center, producing a structure resembling in this respect the composed fan structure of the Alps. There is, however, this great difference between the Marquette structure and that of the Alps, that in passing from the sides of the trough toward the center, newer rocks appear rather than older ones, so that in the center of the synclinorium the youngest rocks are found. It is as if the composed fan folds of the Alps were sagged downward, so that the structure as a whole is a synclinorium rather than an anticlinorium. This form of folding has been elsewhere defined by Van Hise[1] as an abnormal synclinorium. The folding is closer in the western part of the district than to the east. The strikes of most of the exposures of the district are mainly controlled by the east-west folds, but, at the east and west ends of the areas of the formations, the larger north-south folds already described control.

[1] Principles of North American Pre-Cambrian geology, by C. R. VAN HISE, 16th Annual Report U. S. Geol Surv., Part I, 1896, p. 612.

The rocks of the district have yielded to the folding in different ways. Where brittle the close plications have resulted in their being fractured through and through, and in many places they pass into reibungsbreccias. These phenomena are particularly prevalent in the Negaunee iron formation and in the quartzites. The more plastic formations have yielded without major fracturing, but in a minor way they show everywhere the effects of deformation. A microscopical study shows that not a cubic inch of material has escaped dynamic action. While, as a further consequence of dynamic action there has been local faulting at various places, with two or three exceptions, no important faults have been observed in this district.

Because of the varying strength and texture of the various beds and formations, the readjustments necessary in folding took place in large measure between the different formations and between dissimilar beds of each formation. As these layers were rubbed over one another, schistosity was developed parallel to the bedding in many places. The unconformable contacts between the Upper Marquette and Lower Marquette series, and between the Archean and Lower Marquette series, were the greatest planes of movement, and adjacent to them the rocks of both the series were rendered schistose. In the nearly homogeneous Michigamme and other slates there apparently occurred an actual flowage. Here there is frequently a discordance between the cleavage or schistosity and the bedding.

It is inferred from the phenomena of deformation that, when folded, the rocks which are now at the surface were buried under a thickness of several thousand feet of sediments, not impossibly as much as ten thousand feet. On the other hand, it appears that the formations were not so deeply buried as to be beyond the sustaining strength of strong rocks like quartzites, or else the layers of these rocks would have been folded without the production of reibungsbreccias, as in the case of the Doe River quartzite of Tennessee.

As shown by the above facts, the Marquette district furnishes a beautiful instance of deformation in the lower part of the zone of combined fracture and flowage.[1]

The Lower Marquette and Upper Marquette series are correlated with the Lower Huronian and Upper Huronian series of the north shore of Lake Huron. The reasons are stated in previous publica-

[1] Principles of North American Pre-Cambrian geology, by C. R. VAN HISE. 16th Annual Report U. S. Geol. Surv., Part I, 1896, pp. 601–603.

tions, and are not repeated.[1] The succession in the Menominee district of Michigan, as given by Smyth,[2] is compared with that of the Marquette district, and points of similarity and difference noted. It is shown that the series of the two districts may be roughly correlated, but that closer correlation may not be attempted until more detailed studies are made in the Menominee district.

Newett[3] gives a sketch of the Marquette iron-bearing district of Michigan, and publishes a geological map of the district compiled from a map of the Upper Peninsula in the possession of the Michigan Geological Survey. The iron ores occur in the Huronian rocks, of which there are some thirty members. This series of rocks has been subjected to enormous lateral pressure, resulting in foldings in the strata. In the folds the ore is found generally in lenticular masses. The Huronian rocks are cut by eruptive rocks, which have played an important part in assisting in the concentration of the ores.

Gresley[4] describes peculiar markings in iron ore from the Chapin mine of Iron Mountain, Mich., which are thought by H. S. Williams, by Schuchert and by Walcott to be trails of organic origin.

Comments.—At various places in the Menominee district, including the Chapin mine, the Cambrian sandstone unconformably overlies the ferruginous schists of the Huronian. At some localities the lowest horizon of the Cambrian is an iron ore, which has been mined. The question arises whether or not the organic remains referred to by Gresley are contained in the original ore of the Huronian or in the detrital ore of the Cambrian. As the specimens were found in the ore after it had been shipped from the district, it seems impracticable to answer this question, and therefore it is unsafe to conclude that the organic markings are of pre-Cambrian age.

[1] Correlation papers—Archean and Algonkian, by C. R. VAN HISE. Bull. U. S. Geol. Surv., No. 86, 1896, pp. 183–186.

Principles, cit., pp. 796–799.

[2] The Lower Menominee and Lower Marquette series in Michigan, by H. L. SMYTH. Am. Jour. Sci., 3d series, Vol. XLVII, 1894, pp. 216–223.

[3] The Marquette Iron Range of Michigan, by G. A. NEWETT. Proc. Lake Superior Mining Inst., Vol. III, 1895, pp. 87–108. With geol. map.

[4] Organic markings in Lake Superior iron ores, by W. S. GRESLEY. Science, new series, Vol. III, 1896, pp. 622–623.

Van Hise[1] describes baselevels in the crystalline rocks of central Wisconsin and Keweenaw Point. In the Wisconsin district the Archean and Huronian rocks occupying the area are truncated to an even baselevel with an apparent southerly slope. The altitude is about 1450 feet.

On Keweenaw Point the peaks of the main trap range rise to so nearly the same altitude that they form an apparent plain, which is considered an ancient baselevel. The altitude of this plain is about 1350 feet. Certain peaks, consisting of hard quartz-porphyry and felsite, have resisted weathering, and stand above this plain.

The central Wisconsin plain has not been so deeply dissected as the Keweenaw Point area, but this is explained by the fact that it is not so near either of the great lakes, and therefore erosion has not been so effective over it.

From the proximity of the central Wisconsin and Keweenaw Point baselevels, and from the fact that they have nearly the same altitude, it is concluded that the baselevels of the two districts are probably but parts of a far more extensive baseleveled region resulting principally from the subaërial erosion of Cretaceous time, and perhaps also, in part, from the marine denudation of the Cretaceous.

Hubbard[2] describes the relation of the copper vein at the Central mine, Keweenaw Point, to the Kearsarge conglomerate. The veins of Keweenaw Point belong largely to one system, and are confined principally between T 57 N, R 32 W, and the northeast extremity of the Point. The copper-bearing formation between these limits dips N 33° E, at the first locality, to south of east at the last, and the veins are nearly at right angles to the formation. The Central mine is situated in Sec. 23, T 58 N, R 31 W, about eighteen miles northeast of Calumet. Here there has been a northerly sliding of the formations above the Kearsarge conglomerate, as a result of which the copper vein in the overlying formations is found to stop abruptly at the Kearsarge conglomerate. In this mine is the eastern edge of the basin in which the Kearsarge conglomerate was deposited.

[1] C. R. VAN HISE, A central Wisconsin baselevel, Science, Vol. IV, 1896, pp. 57–59; A northern Michigan baselevel, *ibid.*, pp. 217–220.

[2] The relation of the vein at the Central mine, Keweenaw Point, to the Kearsarge conglomerate, by L. L. HUBBARD, Proc. Lake Superior Mining Inst., Vol. III, 1895, pp. 74–83.

Winchell, H. V.,[1] gives a brief sketch of the iron ranges of Minnesota. Along the north side of the Mesabi range is a ridge of Archean syenite and granite, flanked on both sides by crystalline and semi-crystalline schists. This ridge is called the Giant's Range. On the south side of the Giant's Range, lying at times nearly up to its summit, are the outcropping edges of Taconic or Upper Huronian strata, which overlie unconformably the syenites and schists. These are in turn overlapped to the south by eruptive rocks of Keweenawan age and by Cretaceous sediments. The ore is soft hematite, which lies at low angles from the horizontal, usually covered merely by drift.

The geology of the Vermilion Range is not yet understood. The iron ores are solid and massive, except at the Chandler mine, where they are brecciated, and occur in steeply inclined lenses between walls of schist, extending to an indefinite depth.

Lawson[2] describes a family of basic plutonic orthoclase rocks rich in alkalies and lime, which he names malignite, as occurring in the form of a laccolite in the Coutchiching schists of Poohbah Lake. The malignites vary from basic nepheline-pyroxene malignite through garnet-pyroxene malignite to amphibole malignite.

Coleman[3] makes a second report on the gold fields of western Ontario, including the area between Finmark, near Thunder Bay, and the Manitoba boundary, and between Minnesota and Keewatin on the north shore of Lonely Lake. This visit confirms his impressions of the geology of the area as given in the preceding report of the bureau.[4]

At many places the Laurentian rocks show an eruptive contact with the overlying rocks, showing that they must have been consolidated later than the Huronian. Coleman suggests that it would be more logical to confine the name *Laurentian* to the oldest complex of thoroughly crystalline rocks serving as a foundation for all succeeding rocks, and to describe the clearly eruptive rocks which penetrate the

[1] The iron ranges of Minnesota, by H. V. WINCHELL, Proc. Lake Superior Mining Inst., Vol. III, 1895, pp. 11–32.

[2] Malignite, a family of basic plutonic orthoclase rocks rich in alkalies and lime, by ANDREW C. LAWSON, Bull. Dept. of Geol., Univ. of Cal., Vol. I, 1896, pp. 337–362, Pl. 18.

[3] A second report on the gold fields of western Ontario, by A. P. COLEMAN, Fifth Rept. Bureau of Mines, Ontaria, for 1895, Sec. II, pp. 47–106, 1896.

[4] Reviewed in this JOURNAL, Vol. IV, pp. 744–745.

overlying Huronian schists as eruptives, of later age than at least the earlier members of the Huronian. If this were done, very little of the territory under consideration could be mapped as Laurentian —perhaps none of it with certainty. However, the discrimination may not be made until more detailed work has been done in the district.

Coutchiching mica-schists and gneisses, though probably present, have not been certainly recognized. The series of eruptives, pyroclastics, and less common waterworn clastics, Lawson's Keewatin, is of widespread occurrence, and of great importance as containing the gold-bearing veins of the district. It is spoken of under the general term Huronian.

Blue[1] sketches the geological history of the New Ontario, which includes that part of the province of Ontario lying beyond the Matawan and French rivers, and the Nipissing, Huron, and Superior lakes, to the north and west boundaries of the province. Laurentian and Huronian rocks form highlands which in Archean time were the most important physical feature of North America, sweeping in a curve through what is known in our time as the regions of Labrador, Quebec, Ontario, and the Northwest Territories. While there are large areas in which eruptive masses of granite and gneiss have penetrated the Huronian rocks, and thrown them into folds, proving their later age, in general the reverse is the case, the Huronian resting unconformably upon the Laurentian, and being of later origin. The Huronian is overlain unconformably by Cambrian rocks, under the Cambrian being included Animikie, Nipigon, and Potsdam rocks.

Comments.—The term *Cambrian*, as here used, covers Animikie, Keweenawan, and Potsdam rocks. The two former have ordinarily been regarded as pre-Cambrian.

Dowling[2] reports on the geology of the country in the vicinity of Red Lake and part of the basin of Berens River, in the district of Keewatin, Canada. The rocks exposed are all Archean, including gneisses

[1] The New Ontario, by ARCHIBALD BLUE. Fifth Rept. Bureau of Mines, Ontario, for 1895, pp. 193–196, 1896.

[2] Report on the country in the vicinity of Red Lake, and part of the basin of the Berens River, District of Keewatin, by D. B. DOWLING, Ann. Rept. Geol. Surv. of Canada, for 1894, Vol. VII, Part F, 1896, pp. 54. With geological map.

and granites classed as Laurentian, and folded schists and greenstones classed as Huronian.

The Laurentian rocks prevail over a much greater area than the Huronian rocks, being seen along the White and Berens rivers, on Lac Seul, and on the English and Matawan rivers. They are gneisses and granites, the latter in places apparently intrusive in the former, as along the headwaters of the Berens River. The granites are occasionally intrusive also in the Huronian to the south.

The Huronian rocks are a series of schists, limestones, and water-deposited volcanic materials. They occur in two main areas. The eastern one is in the vicinity of Clearwater and Woman lakes. The eastern boundary of this area has not been defined; to the west, the Huronian is in contact with the Laurentian. From the southwestern part of the area, a belt extends southwest to the vicinity of Shallow Lake. The western area of Huronian occurs in the vicinity of Red Lake, and is surrounded by and incloses areas of Laurentian granite and gneiss.

Contacts of the Laurentian and Huronian rocks are described for numerous localities. The contacts are "generally of a brecciated character, the gneisses and granites while in a plastic condition surrounding and inclosing the Huronian schists" (p. 40).

The Huronian rocks are similar in many respects to the Keewatin series of the Lake of the Woods and Rainy Lake districts, to the south: but the Huronian of the area under discussion includes dark blue limestone, and conglomerates with jasper pebbles, both very similar to those of the typical Huronian area north of Lake Huron, and the rocks are accordingly mapped as Huronian.

The Coutchiching, supposed by Lawson to underlie the Keewatin of the Rainy Lake country, is possibly here represented by a small area west of Shallow Lake, mapped as Huronian. However, at Gull Rock Lake, rocks which still more resemble the Coutchiching of the Rainy Lake region are found to be but highly altered Huronian beds in contact with the Laurentian, which, when followed along the strike, take on the general aspect of the remainder of the Huronian of the district.

GENERAL COMMENTS.

In the articles by Blue, Coleman, and Dowling the term *Laurentian* is used to cover both the ancient basement upon which the Huronian rocks were deposited, and later granitic intrusives, although Coleman

recognizes the fact that the logical course is to confine the term Laurentian to the older rocks. This usage of the term is a serious obstacle to the progress of structural geology in this region, for two entirely different series of rocks are confused. Plainly the rocks called Laurentian upon which the Huronian was deposited are pre-Huronian; it is equally certain that the granites called Laurentian which cut the Huronian are Huronian or post-Huronian in age. So long as these two classes of rocks are confused on the maps, no such thing as a structural map of the area northwest of Lake Superior is possible.

C. K. LEITH.